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DEPARTMENT OF TRANSPORTATION
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DOCKET SECTION

The Honorable Philip R. Recht
Deputy Administrator
NATIONAL HIGHWAY TRAFFIC
SAFETY ADMINISTRATION
400 Seventh Street, S.W., Room 5220
Washington, DC 20590

Dear Mr. Recht:

Re: **Settlement Agreement**
Section D. Crash Test Dummy Research & Development

Enclosed are proposed project descriptions and proposed Statements of Work for the following projects for Year 4:

- D. 4 Identification of Injury Mechanisms Resulting in Injuries to the Upper Extremities in Frontal Crashes
- D. 7 Development and Dynamic Testing of a Second-Generation Pregnant Abdomen

Please advise whether you concur in these proposed project descriptions and proposed Statements of Work.

Sincerely,

David A. Collins
Attorney

DAC:dld
Enclosures

c: James A. Durkin, Esq.

D. Crash Test Dummy Research & Development Projects - Year 4

4. Identification of Injury Mechanisms Resulting in Injuries to the Upper Extremities in Frontal Crashes (\$180,000)

The research effort will be continued. Field investigations of crashes involving **airbag** deployments and forearm fractures will continue to be studied, with an emphasis on investigating crashes of 1998 vehicles equipped with depowered **airbag** systems. Laboratory **airbag** deployment testing using unembalmed cadavers will also be continued, with analysis of any resulting upper extremity injuries associated with **airbag** deployment. Modeling of airbag/forearm interactions using MADYMO will continue to be used to explore parameter effects and to help in the design of a test device for the assessment of **airbag** aggressivity.

7. Development and Dynamic Testing of a Second-Generation Pregnant Abdomen (\$128,000)

The research effort will be continued. A second-generation pregnant abdomen will be developed based on results from other related projects, including human measurements taken in the delivery room and anthropometric measurements taken in the simulated motor-vehicle environment. The new abdomen will include design features and instrumentation needed to represent the mechanism of fetal loss due to separation of the placenta from the uterus (abruptio-placenta) due to dynamic loading and inertial forces. Both finite element models and physical prototypes of the pregnant abdomen will be developed and exercised in conditions noted from Projects D.9 Investigations of Pregnancy Loss Resulting from Motor Vehicle Crashes and D. 10 Seated Anthropometry During Pregnancy, that were associated with abruptio-placenta.

Both whole-body (i.e., in-dummy) and component testing of the new abdomen and early prototypes will be used to evaluate the abdomen and instrumentation performance. These tests will be performed with a rebound impact sled and a pendulum impactor. Abdomen testing will be conducted throughout the design and development process and upon completion of the final prototype.

Project D.4
Statement of Work
Year 4

GM/DOT Project Number, Title and Budget:

D.4 Identification of Injury Mechanisms Resulting in Injuries to the Upper Extremities in Frontal Crashes (\$180,000)

Project Description:

The research effort will be continued. Field investigations of crashes involving **airbag** deployments and forearm fractures will continue to be studied, with an emphasis on investigating crashes of 1998 vehicles equipped with depowered **airbag** systems. Laboratory **airbag** deployment testing using unembalmed cadavers will also be continued, with analysis of any resulting upper extremity injuries associated with **airbag** deployment. Modeling of **airbag/forearm** interactions using MADYMO will continue to be used to explore parameter effects and to help in the design of a test device for the assessment of **airbag** aggressivity.

GM Project Manager: Stephen W. Rouhana, Ph.D.
GM Safety Research
Mail Code 480-I 03-001
30500 Mound Road
Warren, MI 48090-9055

Principal Investigator: Lawrence W. Schneider, Ph.D.
University of Michigan Transportation Research Institute
2901 Baxter Road
Ann Arbor, MI 48109

Research Plan: This is a continuation of a project started in the first year of the settlement agreement. The tasks to be undertaken in the fourth year of the settlement agreement are:

1. Conduct field investigations of vehicle crashes involving steering-wheel **airbag** deployments and forearm fractures, with particular emphasis on low-severity impacts and crashes involving 1998 vehicles equipped with depowered **airbags**. It is anticipated that ten to twenty new cases will be investigated. Results will be analyzed to determine the role of the **airbag** in causing forearm fractures and the potential reduction of these injuries with depowered **airbags**.
2. Static **airbag** deployment tests in the laboratory using unembalmed cadavers will continue to be conducted. Tests will be conducted to explore the relationship between distal forearm speed, arm mass, bone mineral density, and the probability and severity of fractures to the radius and ulna. Tests will also be conducted to explore the role of inertial factors in crash decelerations on **airbag/forearm** loading and fracture potential. Also, **airbag-into forearm** deployment tests will be conducted using depowered **airbag** systems.

3. The MADYMO computer model will be used to explore airbag/forearm interaction factors in order to optimize the conditions used in laboratory testing. Simulations will be conducted to examine the relationships between distal forearm speed, forearm mass, and forearm mass distribution, as well as the relationship of distal forearm speed to forearm position and proximity to the **airbag** module.
4. Results of tasks 1, 2, and 3 will be analyzed in relation to possible development of a test device for assessing **airbag** aggressivity with regard to forearm fractures.

Expected Results: The outcomes/products of this project are expected to include a final report and one or more professional journal publications or professional meeting presentations. Accompanying the final report will be the **dataset** for the MADYMO model.

Allocation of Budget: It is estimated that \$175,000 will be spent for the work performed at the University of Michigan and the balance will be for the work performed by the GM Project Manager.

Expected Duration: It is expected that this project will be completed during year 5 of the settlement agreement.

Project D.7
Statement of Work
Year 4

GM/DOT Project Number, Title and Budget:

D.7 Development and Dynamic Testing of a Second-Generation Pregnant Abdomen(\$128,000)

Project Description:

The research effort will be continued. A second-generation pregnant abdomen will be developed based on results from other related projects, including human measurements taken in the delivery room and anthropometric measurements taken in the simulated motor-vehicle environment. The new abdomen will include design features and instrumentation needed to represent the mechanism of fetal loss due to separation of the placenta from the uterus (abruptio-placenta) due to dynamic loading and inertial forces. Both finite element models and physical prototypes of the pregnant abdomen will be developed and exercised in conditions noted from Projects D.9 Investigations of Pregnancy Loss Resulting from Motor Vehicle Crashes and D. 10 Seated Anthropometry During Pregnancy, that were associated with abruptio-placenta.

Both whole-body (i.e., in-dummy) and component testing of the new abdomen and early prototypes will be used to evaluate the abdomen and instrumentation performance. These tests will be performed with a rebound impact sled and a pendulum impactor. Abdomen testing will be conducted throughout the design and development process and upon completion of the final prototype.

GM Project Manager: Annette L. Irwin, Ph.D.
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Principal Investigator: Lawrence W. Schneider, Ph.D.
University of Michigan Transportation Research Institute
2901 Baxter Road
Ann Arbor, MI 48109

Research Plan: This is a continuation of a project started in the second year of the settlement agreement. The tasks to be undertaken in the fourth year of the settlement agreement are:

1. Continue to develop and use a finite-element model (FEM) of a pregnant abdomen to explore the mechanisms and factors involved in fetal loss by abruptio-placenta.
2. Use the FEM to estimate the dynamic response characteristic of a pregnant abdomen.

3. Construct and dynamically test physical prototypes to explore mechanisms of abruptio-placenta, explore abdomen design concepts for the second-generation pregnant dummy, and provide data for FEM validation.
4. Develop, implement, and test the pregnant abdomen design and instrumentation concepts.
5. Consult with First Technology Safety Systems (FTSS) to assure that manufacturability and calibration issues are addressed in the second-generation pregnant abdomen.

Expected Results: The outcomes/products of this project are expected to include a final report and one or more professional journal publications or professional meeting presentations. Accompanying the final report will be a finite element model of the second-generation pregnant abdomen. The final report will also include design documentation for the prototype second-generation pregnant abdomen, in sufficient detail to result in transfer of the technology developed and to enable others to build the pregnant abdomen, reconfigure the standard Hybrid III small female dummy to accommodate the pregnant abdomen, and to use the modified dummy.

Allocation of Budget: It is estimated that \$125,000 will be spent for the work performed at the University of Michigan and the balance will be for the work performed by the GM Project Manager.

Expected Duration: It is expected that this project will be completed during year 5 of the settlement agreement.